

Defining policy options for the provision of research infrastructure in Australia and ensuring adequate access to overseas facilities

SCOPING NOTE

Mark Matthews
Director, Policy Intelligence Pty Ltd

Australian Research Infrastructure Project

Australian Academy of Science

31 May 2002

Note: this *Scoping Note* does not necessarily reflect the views of the Australian Academy of Science or of any of the organisations represented on the project Steering Group.

Introduction

1. This project aims to develop policy recommendations for the funding for Australia's *scientific research infrastructure*, and *major research facilities* in particular. The work is being funded as part of an Australian Research Council (ARC) *Special Projects* grant on Major National Research Facilities (MNRF). This grant was awarded to the Australian Academy of Science (AAS) in 1999. The current project constitutes the concluding piece of work carried out using these funds.
2. This project builds upon earlier work carried out by the AAS, including the Forum '*Major Research Facilities: Towards a National Policy Framework*' held in April 2000 and the Academy's response to the CCST '*Major National Facilities Working Group*' Discussion Paper on this topic. It also builds upon the 'audit' of major national research facilities in Australia carried out by the consultant in a previous study for the (then) Department of Industry, Science and Resources (ISR) in 1999. An updated list of the facilities identified in that audit can be found in Annex B.¹
3. The current study involves:
 - examining *current programs* that support Australia's scientific research infrastructure;
 - assessing *areas of need* on the basis of consultations with applicants for funding from last year's MNRF2 bidding round;
 - explaining how Australian science benefits from *international collaboration* using research facilities, and;
 - examining what can be learned from *policy approaches developed overseas*;

¹ It should be noted that although DEST has asked researchers to inform them if a facility is missing from this list there are still gaps in coverage.

- on the basis of this research, recommending changes to Australia's research infrastructure funding programs.
4. The full Terms of Reference (ToR) can be found in the following section.
 5. The purpose of this *Scoping Note* is to explain how the Terms of Reference (ToR) for this project will be met. This involves:
 - highlighting the importance of instrumentation and research facilities for scientific progress;
 - summarising the current situation as regards funding for major research facilities in Australia;
 - defining the possible areas of overlap between the current work on research priority setting for science and funding for major research facilities and overseas facilities;
 - outlining salient policy issues concerning funding for major research facilities;
 - defining the approach to be taken in carrying out this project in the light of these observations and discussing any problems that may be encountered and how these problems will be dealt with;
 - providing a draft of the questionnaire to be used in consultations with researchers who unsuccessfully bid for MNRF2 funding.
 6. In so doing, this *Scoping Note* aims to provide the project *Steering Group*, and other stakeholders, with an early opportunity for providing feedback and advice on both the substantive issues addressed and on the proposed methodology. This will help to maximise the value-for-money of this project.

Terms of Reference

7. The following Terms of Reference (ToR) were agreed in draft form at the project Steering Group meeting on 9th April 2002.²
 1. Describe existing programs that support research infrastructure for Australian science, in particular:
 - The major National Research Facilities (MNRF) program;
 - Systemic Infrastructure Initiative (SII);
 - ARC's Linkage Infrastructure Equipment & Facilities (LIEF) program;
 - CSIRO, AIMS, ANSTO;
 - Institute of Advanced Studies; and
 - State Government initiatives.
 2. Examine applications to last year's MNRF program to identify areas of particular need that remain in Australia's research infrastructure.
 3. How does Australia benefit from international science and technology collaboration through membership of international projects, such as the Ocean Drilling Program, the Photon Factory, Gemini, International Spallation Fusion Agreement and the International EPSI agreement; and
 - access to major facilities overseas.

² Although there was a discussion of the possible need to modify these Terms of Reference at the Steering Group meeting held to discuss this *Scoping Note* on 30th June any modifications are not now thought to be necessary given the clarification offered by the Steering Group in response to the questions raised in the final section of this *Scoping Note*.

4. Recommend changes to Australia's research infrastructure programs that would advantage the development and maintenance of Australia's research infrastructure; and
 - i take account of the findings of this study,
 - ii take account of examples of good practice from overseas,
 - iii give consideration to recent developments in Commonwealth/State relations in Australia.

Issues for Consideration

The importance of scientific instrumentation and research facilities

8. In many areas of science the rate of progress of knowledge is determined by the capabilities of the *research instruments* used to make observations and carry out experiments. The rate of technological progress in research instruments is consequently a major contributing factor to the overall rate of advance of scientific knowledge. For this reason, scientists are often closely involved in, if not leading, efforts to develop and improve instrumentation technologies. This means that the technologies that spin-off from new developments in instrumentation (many of which have had major economic impacts)³ may not have emerged without the stringent technical demands created by the scientific research involved – often *basic research*.
9. Public sector investment in research facilities (i.e collections of research instruments together with the infrastructure that allows them to operate) is consequently an investment *both* in scientific advance *and* in the potential to generate commercial outcomes.
10. The same point applies to collections of *specimens* and large complex *data-sets*. In many areas (e.g. entomology and geology) research involves *classification* and *pattern recognition* activities that are essential in order to understand natural phenomena. Without collections of specimens and data this analytical work is not possible and the rate of advance of knowledge is constrained. This point applies as equally to basic research as to applied research that may lead to commercial outcomes.
11. For example, oil and gas exploration companies would be unable to be nearly as effective in knowing where to look for hydrocarbon resources if large data-sets on geological structures and their likely paths of evolution⁴ were not maintained using public sector funds. Indeed, the capacity to spot patterns in data on large complex systems is a growing cross-cutting area of scientific research.
12. From a policy perspective therefore, the allocation of funding for research instrumentation and facilities needs to consider the benefits that accrue from both the advances in knowledge sought *and* the potential spin-offs that may take place from invention in scientific instrumentation. Adequate funding for scientific instrumentation is a pre-requisite for efficient and effective science and is also a significant generator of commercialisation options. It follows that the long-term *outcomes* consequent on public sector investment in scientific research facilities should ideally be assessed on this 'dual impact' basis, and these benefits quantified and related to the costs incurred. If this is not done then it can be difficult to demonstrate just how important adequate funding for research facilities is. This is a particularly important issue for major (i.e. expensive)

³ For example in the growth of high technology companies selling research instruments surrounding major research universities such as Oxford, Cambridge and MIT.

⁴ The likely 'geological history' of an area is an important determinant of the probability that hydrocarbon resources are still there to be exploited. This requires very sophisticated analysis and modelling.

research facilities because funding levels are relatively high and budgetary pressures will therefore tend to limit such funding unless the benefits can be clearly stated.

13. This suggests that there may be important *outcome measurement requirements* associated with capturing the value of public sector investment in the research infrastructure as an integral part of any recommendations made on funding and program structures.
14. Ensuring adequate access to research instruments involves two main areas of activity: the construction, maintenance and upgrading of facilities in Australia or operated by Australia overseas *and* funds to allow other overseas facilities to be used effectively.
15. Previous research on major research facilities in Australia and on access to overseas research facilities has highlighted the critical role of *uncertainty* over such funding.⁵ This applies to the following areas of activity:
 - uncertainty over future funding for research facility operation, maintenance and upgrading once a facility has been built;
 - uncertainty over future funding for building new research facilities or for major upgrades to existing facilities;
 - uncertainty over the availability of funds to travel to, and to use, overseas research facilities and facilities elsewhere in Australia.
16. Given the critical importance of access to adequate research facilities (instruments, specimens and comprehensive data-sets) uncertainty over future funding can cause major problems. Some scientists report that they would be happy to trade-off smaller but more certain streams of funding for larger but lumpy and uncertain funding.⁶ Uncertainty over funding makes it difficult to plan ahead and to keep research teams together. On the other hand, a significant level of uncertainty is inevitable if merit-based funding allocations are to be used to optimise how budgets are spent. The resulting trade-off is difficult to manage, and funding for major research facilities provides a good example of this policy dilemma. The challenge is to find a way of maximising merit-based funding whilst minimising uncertainty over future funding.
17. The risk of making large periodic funding allocations for major research facilities, with high uncertainty over whether such funds will be available in the future, is that bids will tend to be made when it suits the funding round *not* when it suits to actual need for investment in a research facility. In addition, there is a risk that adequate funds will not be available to operate, maintain and upgrade a facility once it has been built. The case in favour of *less* uncertainty over funding for major research facilities therefore needs to address the twin issues of ‘funding cycle co-ordination’ and of ‘life cycle’ funding requirements.
18. One way of thinking about these problems is to consider *discount rates*.⁷ Scientists characteristically (by choice of career) prefer low discount rates (i.e. they tend to value long-term benefits relatively highly compared to short term benefits) – a *research training takes time and the rewards take a long time to arrive*. ‘Ad hoc’ funding for major research facilities may have the effect of driving up scientists’ subjective discount rates – forcing them to become more short-term than they would otherwise be. For instance, to seek funding for building facilities even though they are aware that there is a high risk that this investment will not be effective over the long and medium term because there is a high chance that the facility cannot be operated and/or upgraded

⁵ ‘Audit of Major National Research Facilities and the Use of Overseas Facilities – 1999’, Report for the Commonwealth Department of Industry, Science and Resources, Howard Partners, 1999.

⁶ Informal consultations carried out during the 1999 Major Research Facility Audit for ISR.

⁷ A discount rate reflects perceptions of time preference, risk and uncertainty. A low discount rate means that benefits in the future are valued more highly than they are with a higher discount rate – leading to longer term time horizons in decision-making.

properly. This results in a ‘feast and famine’ funding cycle that reduces the efficiency and effectiveness of the nation’s stock of research facility ‘capital’.

19. Examining the discount rate issue is pertinent to making policy recommendations because the relatively high discount rates used in private sector resource allocations guide and limit business enterprise R&D investment – hence the need for public sector R&D investments. In other words, the market and institutional failures, and the public good rationales, for public sector investment in R&D partly address problems caused by the use of high discount rates in investment decision-making. It follows that the public sector R&D investments associated with the nation’s research infrastructure could be guided, in part, by discount rate based objectives. It makes little sense to adopt policies towards research infrastructure funding that, effectively, encourage the short-termism and high discount rates that limit private sector investment in R&D. Yet, this may be precisely the situation in which we find ourselves.⁸
20. Another economic consideration relevant to research infrastructure funding concerns the rate of economic depreciation. The issue of high economic depreciation rates for some types of research facility has already been highlighted in discussions on an appropriate policy framework.⁹ These high depreciation rates are caused by the rapid rate of advance of instrumentation technology – which can outdate a facility relative to the international state-of-the-art very rapidly. They can be as high as 40% per annum in the life sciences. Facility operators report that they are unable to reflect these economic depreciation rates in their user fees – partly because academic research grants do not permit expenditure for depreciation related costs. *Note: these are the depreciation rates caused by technological obsolescence and do not necessarily relate to those currently used in research organisations’ and universities’ accounts.*
21. One option for policy formulation may consequently be to design a funding program for major research facilities that does not distort scientists’ (low) implicit discount rate and which incorporates economic depreciation into funding provision. This would amount to ‘life cycle’ support for research facilities.

Overlap with research priority setting

22. Current discussions on scientific *research priorities* provide an opportunity to explore such a concept. This is because it is necessary to have chosen research priorities as a precursor to deciding on the research areas that could receive life cycle funding for their research infrastructure. It is not feasible to try make such long-term funding commitments without the ‘mesh’ with a research priority framework. The caveat is that the research priorities that are set must be sufficiently *stable* through time to be able to provide this consistency.
23. On a more general level, the critical role played by access to research facilities (whether domestic or overseas) as a determinant of contributions to scientific advance, and the cost of ensuring this access, does have important implications for *any* priority setting process. Setting research priorities involves some form of weighing up of what the nation would like to be good at and *what it can afford to be good at*. Given that any consideration of ‘what we can afford to be good at’ entails an assessment of what research facilities we can afford to build *and keep up to date* any recommendations on funding for major research facilities should not (ideally) be made independently of the priority-setting exercise. Consequently, this project is well timed. It is important to seek to maximise the exchange of information between this study and the wider process of priority-setting.

⁸ The United States uses its large ‘mission oriented’ component of the public sector R&D effort (NASA and the DoD, NIH etc) to facilitate long-term (low discount rate) R&D investments.

⁹ The Forum ‘Major Research Facilities: Towards a National Policy Framework’ organised by the AAS in April 2000.

24. The recently released ‘Issues Paper’ on the Howard Governments’ plans for developing national research priorities notes the importance of “*the availability, quality and scale of necessary research infrastructure*” (page 14) but does not highlight the ‘affordability’ of research infrastructure issue as an intrinsic part of the priority setting *process*. It may therefore be worth seeking to raise the profile of the affordability issue via this project.
25. On a practical level this means seeking to define the common ground between any analysis of the *attractiveness* and the *feasibility* of different research areas *and* the issue of the affordability of the research facilities required to support these research areas. Perhaps the best way to do this (though this may not be possible to *fully* complete within the confines of the budget for this particular AAS project) would be to provide data on the anticipated *life cycle costs* of providing state-of-the-art research facilities in major research fields. These estimates could then be used as part of any assessment of the *feasibility* of making this field a priority research area using Australia-based research facilities. It consequently makes sense to seek to collect estimates of these life cycle cost as part of the survey work carried out via this project. This is unlikely to be a comprehensive data-set – but it would be a start at constructing such a data-set. Applicants for funding under MNRF2 may be well positioned to provide such estimates.

The current funding structure

26. The current structure for funding the nation’s research infrastructure consists of a mix of specific programs and budget allocations to various R&D performing organisations, a proportion of which is then spent on building, upgrading and maintaining research facilities.
27. As far as specific programs are concerned it is relatively easy to identify objectives and actual funding allocations – such information is readily available on web sites and some the information available on the LIEF program is presented in the following exhibit.

Funding Program/Budget Item:

- **Linkage Infrastructure Equipment & Facilities Program (LIEF) – administered by the Australian Research Council (ARC)**

Objectives & Focus:

- Encourage institutions to develop collaborative arrangements amongst themselves, across higher education sectors and with organisations outside the sector, to develop research infrastructure
- Support large-scale cooperative initiatives involving two or more institutions thereby allowing expensive facilities to be shared
- Enhance support for areas of research strength
- Ensure that areas of recognised research potential have access to the support necessary for development.

Budget Value

- \$24,675,255 allocated in 2002.

Latest Applications and Funding Data

- 129 applications for 2002 round funding received, seeking a total value of \$61.4m in funding. Partner contributions in all applications totalled \$38,379,000.
- 61 projects (47%) were recommended for funding. The successful applicants sought \$30,932,000 with partner contributions of \$18,680,000. \$24,6575,255 was allocated, representing 80% of the total funding level sought.
- A breakdown of applications and of funded projects by Primary Field of Research and by institution is available at: http://www.arc.gov.au/necgp/outcomes/feed_li.htm

28. It is possible to determine which research facilities are being built, upgraded and maintained using funds received by R&D performing organisations (such as CSIRO, ANSTO and AIMS) by examining the relevant Annual Reports. This task has, however, been made a lot easier due to the availability of the results of the 1999 audit of major national research facilities (since updated by DEST) – see Annex B. There is, however, still a gap associated with the smaller facilities that were not covered by that exercise (a threshold replacement value of \$5m was set).
29. As a result, it is not particularly easy to assemble data on the current funding structure because this is rather complex, and includes discretionary use of general funds mixed with infrastructure specific funding and private and non-profit sector funding contributions. Given the importance of understanding the nature and extent of Australia’s funding for research infrastructure ‘in the round’ it would be useful to attempt to piece together the overall picture – perhaps in the form of an input-output table.¹⁰

Proposed working definition of ‘Major Research Facilities’

30. The following *working definition* of a ‘major national research facility’ (MNRF) has been developed for use in this study. This definition avoids specifying a threshold value of replacement cost and/or capital investment because this excludes research facilities that might best be developed by starting small and growing in an evolutionary manner. *This definition still requires refinement and a revised definition will be provided in the planned Discussion Paper*

Working definition of Major National Research Facilities

Major National Research Facilities (MNRF) are those facilities that are so costly to build *and to keep up to date* that decisions must be made as to whether Australia would be best served by **one** such facility. A MNRF may be ‘virtual’ in the sense that it need not be located in one geographic area. It consists of an assemblage of research instruments, data, and/or specimens that are critical to making progress at or near the leading edge of research.

The process of allocating funding for a MNRF will characteristically balance the costs and benefits associated with building and maintaining a MNRF in Australia with the costs and benefits associated with obtaining access to comparable research facilities overseas. Except where national security issues exist, a MNRF will be used by researchers from a range of institutions and agencies, often via a competitive process based on merit.

As in the current Federal Government definition of MNRF’s, these facilities can also include facilities that support the industrial competitiveness and the rapid commercialisation of research provided that the market and institutional failures that limit private sector funding to levels below those in the wider public interest are clearly delineated.

¹⁰ An input-output table would provide an effective means of assembling this information by allowing the ‘split’ of general R&D funding into infrastructure and non-infrastructure components to be estimated and calibrated against the ABS figures on capital expenditure within R&D (at suitable levels of aggregation). The increasingly ‘intertwined’ nature of the Australian R&D system (e.g. the CRCs) requires this sort of approach.

Executing the Terms of Reference

31. This section of the *Scoping Note* discusses how each task in the *ToR* will be delivered and how any anticipated problems can be addressed. This discussion provides an opportunity to raise issues to be dealt with by the Steering Group.

Task 1: Description of existing programs that support the research infrastructure for Australian science.

32. The purpose of this task is to establish a ‘base line’ assessment of the current funding structure against which subsequent policy recommendations will be made. The *ToR* adopts a broad focus by highlighting programs that directly or indirectly fund the entire research infrastructure (though it does not, for example, mention DSTO, Geoscience Australia, universities in general and the CRC programme). Given this wide scope it might be useful to clarify just how broad the focus of the project should be. Should the focus be on the overall research infrastructure or should it focus more narrowly on the ‘major’ research facilities with this assessment of the wider range of programs used mainly to put MNRFF funding into context? *It would be useful if the Steering Group could clarify their views on the relative emphasis to be placed upon ‘major’ vis-à-vis all other aspects of research infrastructure funding, not least because a major part of this study will involve following-up on MNRFF applications.*

33. The Steering Group’s response was that the main emphasis in the study should be on ‘major’ research facilities with the description of the other programs and funding mechanisms used as context to the discussion of support for major research facilities.

34. Task 1 will be carried out by examining information already in the public domain (web material and annual reports etc) augmented where necessary by consultations with senior staff in universities and government research organisations in order to obtain more information on their infrastructure investments and current ‘stocks’ of research facilities. It will also be possible to draw on the data from the 1999 audit of MNRFFs.
35. It is not anticipated that any significant difficulties will be encountered in Task 1, save perhaps for an element of ‘consultation fatigue’ amongst staff in universities and the larger research organisations.

Task 2: Examining unsuccessful applications to MNRFF2 in order to identify areas of need

36. The main emphasis in these consultations is on finding out what has happened to the proposal since MNRFF funding was refused and on understanding what the proposed facility or upgrade seeks to achieve and the wider implications for Australia’s science and innovation capability. The approach to be used will involve carrying out a series of telephone interviews with the researchers who led the bids. A standard set of questions will be used to structure these interviews. These questions will also allow bidders’ views to be quantified in such a way that they can be summarised in the report on this study. The questions will be organised in a questionnaire – which will be e-mailed to consultees prior to the interview.
37. This questionnaire will be formatted using embedded data entry fields in order to allow it to be completed and returned by e-mail should a telephone interview not be possible. A preliminary draft of this questionnaire is contained in Annex A. The option will therefore exist to place this questionnaire on the AAS web site and, by publicising this project, invite research team leaders who did not bid for MNRFF funding to download it and complete it. *It would be useful if the Steering Group could indicate whether or not it may wish to use such an option.*

38. The Steering Group agreed to the questionnaire being placed on the project web site in a suitable form for use by other research teams in communicating their views to the project.

Task 3: explaining how Australia benefits from international S&T collaboration through membership of international projects

39. This task is, presumably, mainly intended to demonstrate why funding for international collaboration involving access to research facilities is important for Australian science and technology. *In order to decide how much effort should be devoted to this task it would be useful if the Steering Group could clarify its expectations over the level of detail that should be sought.* There would appear to be too possible levels of detail in a study of this type. Firstly, a fairly general account of the importance of participating in these collaborations designed to highlight in general terms how much slower progress would be without such participation – using some quotes and illustrations provided by scientists. Secondly, a more detailed account of these benefits that draws out more research field specific information. The second level of detail would require a significant level of consultation that would stretch the budget for this study.
40. From a recommendations-focussed perspective, it would seem sensible to opt for the first option and to aim to simply to highlight, using these examples, why funding for this type of collaboration should be a central feature of government R&D funding. The main reason for doing this is the reported public and political perception (fairly unique to Australia) that overseas travel is a ‘nice to have’ rather than ‘necessary to have’ aspect of R&D funding.

41. The Steering Group took the view that a general account of the overall importance of these international collaborative activities would suffice.

Task 4: Making recommendations

42. The consultant’s advice is that this task would best be achieved using a two-stage process. In the first stage, available material and an initial tranche of consultations will be used to produce a short *Discussion Paper*. This *Discussion Paper* would summarise the current funding and policy situation (covering amongst other things the issues noted in the ‘Issues for Consideration’ section of this *Scoping Note* – with a particular emphasis on the ‘what can we afford’ aspects of priority-setting) and would air some possible recommendations. Feedback and submissions would be solicited. The *National Research Priorities Forum* on 26-27 June would be a suitable occasion to circulate this *Discussion Paper*. The paper would be placed on the AAS web site, circulated in hard copy form to key policy-makers and could perhaps be offered as a contribution to the Forum.
43. A four-week consultation period could be offered, allowing feedback to be collated and interpreted and a revised paper produced in mid-August. *There are clear benefits in adopting this sort of two-stage process in this case and it is strongly recommended that the Steering Group endorse this approach.*

44. The Steering Group endorsed the approach suggested.

Conclusions

45. Given the current discussions over research priority setting, and the importance of funding for research infrastructure in determining what can be achieved, this is a well timed project. Considerable efforts will have to be made to ensure that this project makes useful inputs to the larger priority setting exercise.
46. This *Scoping Note* has flagged up the issue of providing adequate *life-cycle* funding for research infrastructure, and major research facilities in particular, and suggested that any

data on anticipated life-cycle costs by research field that can be collected might be one useful input to the priority setting process. The ad hoc and ‘high discount rate’ nature of funding for major research facilities to date does not appear to generate adequate life cycle support for research facilities – particularly with respect to provision for economic depreciation due to technological obsolescence. It may, for example, be worth exploring the extent to which changes could be made to research grants to allow facility use fees to include an element to contribute to the costs of the economic depreciation of the research facility. Indeed, one option might be to place public sector funding to cover economic depreciation at the heart of a research infrastructure funding program rather than try to avoid addressing this problem.

47. The possibility that the research priority setting exercise may be a critical enabler of any move towards life cycle funding for research facilities may help to counter balance the scientific research communities concerns over the advent of priority setting. In principle, priority setting should result in reduced uncertainty over future research funding streams and this should benefit Australia’s research infrastructure *provided that the critical role of domestic research facilities, and access to overseas facilities, is explicitly recognised in these research priorities. This project should aim to ensure that this critical role is recognised by providing the data necessary for ‘evidence based’ policy.*

- END -